IN THE DRAWINGS

Replace Figures 1a, 1b, 3a, 3b, 4a, 4b, 6 and 8 with new Figures 1a, 1b, 3a, 3b, 4a, 4b, 6 and 8 enclosed herewith.

REMARKS

Prior to the present amendment, Claims 1-26 were pending. With the cancellation of Claim 7, and the addition of Claim 27, Claims 1-6 and 8-27 are currently pending. In addition to the foregoing amendments to the claims, the title, drawings and specification have been amended to obviate the objections thereto raised in the outstanding Office Action. Reconsideration of the present application in light of the foregoing amendments and following remarks is respectfully requested.

With respect to the objections to the drawings, the following comments are offered.

In paragraph 1 on page 2 of the outstanding Office Action, the drawings have been objected to under 37 CFR 1.83(a), making reference to the heating element that must be shown in the drawings, or be canceled from the claims. In response, Applicants respectfully point out that the heating element 400 is shown in the original Figure 10, and therefore request that the objection under 37 C.F.R. 1.83(a) be withdrawn.

The objection to the drawings under 37 C.F.R. 1.84 (p)(4) makes reference to the use of the apparent duplicate use of the reference character "126" in the drawings, as it appears to designate a laser diode beam in Figures 2, 3, 7, and 8, and an output beam in Figures 3a and 3b. Applicants respectfully point out that the reference character "126" in each of original Figures 2, 2a, 3a, 3b, 7 and 8 designates the same

"at least partially collimated laser diode beam". Notwithstanding, Applicants acknowledge that the manner in which this beam is referred to in paragraphs [0038] and [0050] of the specification may be seen as inconsistent. Applicants have therefore amended paragraph [0038] of the specification to more clearly define the beam 126 as the "*at least partially collimated laser diode beam 126, also referred to hereinafter in the specification as the laser diode beam 126*". Applicants have also amended the wording referring to the beam 126 in paragraph [0050] of the specification, wherein Figures 3a and 3b are described, to comply with the amended definition of the beam 126.

In original Figure 6, the laser diode beam 126 was mistakenly labeled with reference character "130". Figure 6 has therefore been amended to include the reference character "126", in place of the original reference character "130", which has been deleted.

The Office Action further objects to the apparent use of the reference character "140" to designate both "high-power beam and output laser beam", and states that it is unclear how "140" can be an output beam" in Figure 9. Applicants respectfully submit that the beam 140 is both an output beam of the Littrow-stabilized laser diode 1 (as it is emitted from the transmission grating 135), and an input beam for the frequency-doubling configuration of elements shown in Figure 9. Accordingly, to avoid any potential confusion, paragraph [0051] of the specification has been amended to delineate the fact that the laser output beam 140 is also referred to as the

high-power beam 140 in the context of the frequency-doubling embodiments of the laser apparatus of the present invention.

Paragraph [0042] of the specification and Figures 4a and 4b have been amended to include reference characters "137", "411" and "401" to designate the anti-reflection coating, the periodically corrugated surface and the transparent material, respectively. The anti-reflection coating 137 is also shown in the original Figures 2 and 2a. Applicants are grateful to the examiner for pointing out the duplicate use of reference characters "410", "420" and "400" in the specification.

Paragraph [0050] of the specification and Figures 3a and 3b have been amended to use the correct reference character "115" in place of the reference character "123", to refer to the previously introduced light 115 beam emitted by the laser diode chip 100, and to conform with the remainder of the descriptive text and with Figures 2, 2a, 6, 7, and 8.

The last paragraph [0053] of the specification has been amended to include the correct reference character "140", in place of reference character "145", to designate the beam.

To obviate the objection under 37 C.F.R. 1.84(p)(5), reference characters "99", "117", "137", "160" and "175" are now included in amended specification paragraphs [0042], [0045], [0053] to refer to respective elements shown in Figures 2, 2a, and 6, with appropriate wording identifying these elements. No new matter has been introduced.

In addition, Figure 8 has been amended to replace reference character "573" (not referred to in the original specification) with reference character "563", identifying the nonlinear crystal, that is also shown in Figure 7, and referred to in paragraph [0060] of the original specification.

In summary, the Figures have been amended as follows.

Replacement Figures 1a and 1b are now explicitly designated as "Prior Art". Replacement Figures 3a and 3b include the correct reference character "115", in place of reference character "123" in the original drawings. Replacement Figures 4a and 4b include new reference characters "411" and "401", in place of the original duplicate reference characters "400", "410", and the correct reference character "137", in place of the original reference characters "410" and "420". Replacement Figure 6 includes the correct reference character "126", replacing the original reference character "130". Finally, replacement Figure 8 includes the reference character "563", replacing the original reference character "573". As such, it is respectfully submitted that the drawings comply with Patent Office practice. Withdrawal of the objection to the drawings is, therefore, respectfully requested.

The objection to the title is believed to have been overcome by the new title that corresponds to that suggested in the outstanding Office Action.

Claims 23, 25 and 26 have been rejected under 35 U.S.C. 112, as reciting the limitation "the frequency-doubled beam"

without providing sufficient antecedent basis for this limitation. Claim 25 has also been rejected as reciting "said control means" and "the nonlinear element" without having appropriate antecedent basis in the claims upon which Claim 25 depends.

In response thereto, Applicants have changed the phrase "the frequency-doubled beam" in claims 23, 25 and 26 to read "the frequency-doubled output beam". Also, Claims 22 and 23 have been amended to depend on Claim 4, and Claim 4 has been amended to define "a frequency-doubled ~~optical~~ output beam", to provide the antecedent basis of this limitation.

In addition, Claims 25 and 26 have been amended to depend on Claim 24, which provides antecedent basis for the limitations "said control means" and "the nonlinear element" in Claim 25. Also, Claim 26 has been amended to change the phrase "the heating element", to read "the optical detector".

Claims 23, 25 and 26 are now believed to comply with 35 U.S.C. 112, and Applicants respectfully request that the rejection thereof be withdrawn.

In addition to the foregoing amendments to eliminate the indefiniteness rejection under 35 U.S.C. 112, independent claim 1 has been amended to include the term "bulk", so as to clearly define the transmission grating as a bulk transmission grating, and to include the wording

"... grating disposed in the optical path for receiving the at least partially collimated beam"

in place of the original wording

"... grating optically coupled to receive the at least partially collimated beam",
so as to more clearly define the position and function of the transmission grating in the laser apparatus.

Dependent claims 2, 3, 8, 13-16, 18, 19 have also been amended to include the limitation "bulk" with reference to the transmission grating.

New Claim 27, which depends on original Claim 5, has been added in place of canceled Claim 7. Support for this claim can be found in paragraph [0064] of the original specification.

Independent Claim 1 and Claims 3-6, 8, 12 and 14 dependent thereon, have been rejected under 35 U.S.C. § 102(e), as anticipated by Suganuma et al. (US Patent Application Publication 2002/0012377, hereinafter referred to as Suganuma et al).

Independent Claim 1 and its dependent Claim 13 have been also rejected as anticipated by Sidorin et al. (US Patent Application Publication 2003/0214700, hereinafter referred to as Sidorin et al).

Original independent Claim 1 defined a laser apparatus comprising a) a laser diode having a reflective back facet and a front facet having a reflectance of less than 1% for emitting an optical beam, b) collimating means for collimating the optical beam, and c) a transmission grating for returning a portion of the collimated beam back into the laser diode, wherein the laser diode reflective back facet and the

transmission grating form an extended laser cavity, and at least a substantial portion of the of the collimated beam is transmitted through the grating for producing the laser output beam.

Applicants have amended Claim 1 to define that the portion of the collimated beam which is returned back toward the laser diode by the transmission grating is "less than 10% in power so as to provide optical feedback into the laser diode between 1% and 5%". Support for this limitation can be found in paragraphs [0038] and [0065] of the specification.

Of the two prior art references relied upon in the rejections of Claim 1, Suganuma et al disclose, for example, in Figure 20, referenced in the Office Action, an external resonant laser comprising a semiconductor laser 1, a collimating lens 2 and a volume hologram 3 operating as a three-dimensional transmission grating that diffracts a portion of the laser diode beam back into the semiconductor laser. Sidorin et al discloses, for example, in Figure 1A, an external cavity optical source comprising a laser diode 100 coupled through a collimating lens 120 to a transmissive diffraction device 115 providing wavelength selective feedback to the laser diode 100.

However, neither the Suganuma et al nor Sidorin et al discloses, teaches or otherwise suggests, a transmission grating, a volume hologram, or a diffraction device for diffracting back "less than 10% in power" of the laser beam for providing the low optical feedback "between 1% and 5%" into a laser diode.

Moreover, it is respectfully submitted that both Suganuma et al and Sidorin et al teach away from the requirement of a low, less than 10%, diffraction efficiency transmission grating for providing between 1% and 5% optical feedback, as claimed in amended Claim 1, by specifying that the volume hologram (of Suganuma et al) and the diffraction device (of Sidorin et al) have high diffraction efficiencies.

In particular, paragraph [0194] of Suganuma et al reads as follows:

> "*the … volume hologram (3) has a high diffraction efficiency. The laser can therefore emit a laser beam of any desired wavelength at high efficiency*". (Emphasis added)

Similarly, paragraph [0182] of Sidorin et al describes that the TM polarization of light incident on the diffraction device 115 that provides a higher, up to 100%, diffraction efficiency is preferable, as follows:

> "[0182] The diffraction performance of a diffraction device 115 depends on the polarization of the incident light. … For low and very low blaze angles, TM-polarization is known to result in generally higher diffraction efficiency, with theoretical peak values of 100%, while TE-polarization is diffracted with generally lower efficiency. Hence in embodiments of the present invention it would at least usually be preferable to choose TM-polarization of incident light with respect to the diffraction device…." (Emphasis added)

It is common practice in the field of external cavity lasers employing bulk diffraction gratings to use gratings having high diffraction efficiency, which is advantageous for lowering the laser threshold and for providing a wide

wavelength tuning range, and is consistent with Suganuma et al's and Sidorin et al's use of high diffraction efficiency gratings.

Contrary to this prior-art approach, the present invention employs a bulk transmission grating that returns back to the laser diode less than 10% of the laser radiation, i.e. has less than 10% diffraction efficiency, for providing a low optical feedback between 1% and 5%. To Applicants' knowledge, this is a novel feature of the invention, that was found to be advantageous for providing high-power kink-free laser operation at low cost, using commercially-available laser chips, such as those widely used for high-power pump laser diodes, but which has not been seen heretofore in extended cavity lasers with optical feedback from bulk gratings.

Accordingly, Applicants respectfully submit that amended independent Claim 1 includes features that are not anticipated by Suganuma et al or Sidorin et al, and therefore respectfully request that the rejections under U.S.C. 102 of Claim 1, and Claims 3-6, 8, 12 and 14, dependent thereupon, over Suganuma et al, and Claim 1 and Claim 13, dependent thereupon, over Sidorin et al, be withdrawn.

Claims 1, 7, and 18-20 have been rejected under 35 U.S.C. 103 as being unpatentable over the U.S. Patent No. 6,600,563, to Bahatt et al, in view of Sidorin et al. This rejection is respectfully traversed.

It is Applicants' understanding that, in order to establish a prima facie case of obviousness, all of the claim limitations must be taught or suggested by the prior art. The combination of Bahatt et al and Sidorin et al fails to teach or suggest returning a portion of the laser beam back to the laser "so as to provide optical feedback into the laser diode between 1% and 5%", as claimed in amended Claim 1.

As noted above, Sidorin et al do not disclose this feature. Bahatt et al discloses an optical resonance analysis system using an illumination means 400 that comprises a laser diode 10 and a pre-dispersive grating 50 for dispersing illumination from the diode laser at a plurality of angles toward a sensor means 60. In paragraph 14, on page 11 of the Office Action, reference is made to the following statement of Bahatt et al (Column 13 lines 42-43):

> "The transmission of this grating for 'p' polarized light is around 90%".

However, nowhere do Bahatt et al teach that the grating provides optical feedback between 1% and 5% to the laser diode 10. Applicants respectfully submit that the pre-dispersion grating of Bahatt et al is not for the purpose of providing optical feedback into the laser diode, but rather for "*for dispersing the 830-910 nm wavelength range*" toward the sensor means 60 "*to match the resonance angles*", as recited in column 13, lines 40-41 of Bahatt et al.

In column 12, lines 55-64, Bahatt et al further describe the function of the grating in their system as follows:

> "To generate a narrow resonance using a polychromatic source, the sample has to be illuminated at a different resonance angle for each wavelength in the light source spectrum. The relationship between the wavelength and the angle defines the resonance dispersion curve. The slope of this curve is the resonance dispersion (R.sub.Disp). One way to achieve this, *is by using an optical grating* with the same dispersion, oriented correctly between the light source and the sensor."

Applicants respectfully submit that amended independent Claim 1 includes features that are not taught or suggested by either Bahatt et al or Sidorin et al, and therefore respectfully request that the rejections under 35 U.S.C. 103 of Claim 1 and Claims 18-20 dependent thereupon in view of Bahatt et al, Sidorin et al, and also in view of Naganuma, U.S. Patent No. 6,452,720, cited in connection with claim 19, be withdrawn.

Claim 2 has been rejected as being unpatentable under 35 U.S.C. 103 over Suganuma et al, in view of Cook, U.S. Patent No. 6,432,471.

The deficiencies of Suganuma et al with respect to Claim 1, upon which Claim 2 depends, have been addressed. The secondary reference to Cook discloses a method for generating an anti-reflection coating for a laser diode, using an external cavity laser diode system 16 having a transmissive grating 30, wherein "The lasing wavelength is changed (i.e., tuned) by rotating the grating 30 about an axis 32 perpendicular to the beam axis 34". Like Suganuma et al, Cook fails to teach or suggest returning a portion of the laser beam back into the laser "so as to provide optical feedback

into the laser diode between 1% and 5%", as claimed in amended Claim 1.

Accordingly, Applicants respectfully submit that Claim 2, which depends on amended Claim 1, is patentable and requests that the rejection under 35 U.S.C. 103 be withdrawn.

In paragraphs 15-23 of the outstanding Office Action, dependent Claims 9-11, 15-17, and 21-26 have been rejected as unpatentable over Suganuma et al, in view of Yang et al, U.S. Patent No. 6,704,509, Swanson et al, U.S. Patent No. 5,956, 355, Allenson et al, U.S. Patent No. 6,829,278, Ziari et al, U.S. Patent No. 6,215,809, Govorkov et al, U.S. Patent No. 6,614,584, and Daiber et al, U.S. Patent No. 6,816,516, which, in various combinations, are said to disclose various particular features claimed in the dependent claims.

Applicants contend that none of the patents cited in the outstanding Office Action, including those referenced in paragraphs 15-23 thereof, discloses, teaches or suggests the bulk transmission grating for "returning less than 10% of the laser beam back toward the laser diode so as to provide optical feedback into the laser diode between 1% and 5%", as claimed in amended Claim 1, whereupon Claims 9-11, 15-17, and 21-26 depend. Applicants therefore respectfully request that the rejection of these dependent claims be withdrawn.

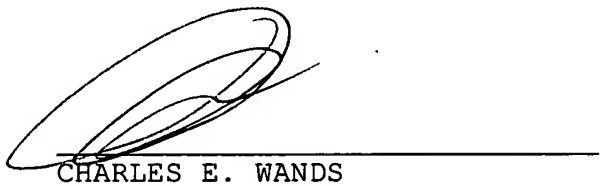
In view of the foregoing amendments to the claims, drawings, and specification, which, for the reasons discussed above, are believed to obviate each of the objections and grounds of rejection advanced in the outstanding Office

Action, and thereby place the claims in condition for allowance, favorable reconsideration of this application and a notice of allowance of Claims 1-6 and 8-27 are respectfully requested.

Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Please charge any shortage in fees due in connection with the filing of this paper, including Extension of Time fees, to Deposit Account No. 50-1465 and please credit any excess fees to such deposit account.

Respectfully submitted,



CHARLES E. WANDS
Reg. No. 25,649

CUSTOMER NO. 27975

Telephone: (321) 725-4760

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